Chapter 8.3

Fish kill trends in the Maryland Coastal Bays

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Abstract

Fish are analogous to "canaries in coal mines". As such, fish kills are usually indications of unusual stress in the environment. Sporadic fish kills due to low oxygen are apparently increasing in frequency. There have been 51 reported fish kills and 49 confirmed or probable fish kills in the Coastal Bays Region since 1984. Collectively they represent approximately 3.3 million mortalities. The majority of fish kills occur in the summer months when there are abundant algal blooms, lower oxygen solubility, increased temperatures, increased oxygen demand from the breakdown of organic matter in the water, and larger fish stocks in the bays. Low dissolved oxygen is implicated in two thirds of all fish kills where the cause is known in the Coastal Bays. The vast majority (97.9%) of mortalities also occurred within dead-end canals.

Introduction

Fishkill investigations are the responsibility of the Maryland Department of the Environment under Environmental Article Section 4-405C to investigate the occurrence of damage to aquatic resources, including, but not limited to, mortality of fish and other aquatic life. The investigations should determine the nature and extent of each occurrence and endeavor to establish the cause and sources of the occurrence. If appropriate, findings shall be acted upon to require the reparation of any damage done and the restoration of the water resources affected, to a degree necessary to protect the best interest of the state.

Since 1984 this program has received over 2,300 reports of fish kills and coordinated a statewide, multi-agency cooperative response to those reports. Not all reports are investigated for a variety of reasons, including low numbers of dead fish, tardy reporting, or *a priori* information on the source of the dead fish. The Fish Kill Investigation Section maintains a database of all reports, investigation results, and other pertinent details from the last 20 years. This report is a summary of events reported in the Coastal Bays region from 1984-2003.

There have been 51 reported fish kills and 49 confirmed or probable fish kills in the Coastal Bays Region since 1984. Collectively they represent approximately 3,300,000 mortalities. During the same period, there were 1,259 fish kill reports, involving approximately 35,000,000 mortalities in the Chesapeake Bay and its tidal tributaries.

Management Objective: Decreasing fish kills that are not 'natural in origin'.

***Draft* Fishkill Indicators:** Number of fishkills due to low D.O. and pollution
Number of dead fish

Status of fish kills

Fish kills in the Coastal Bays were generally confined to dead-end canals. Canals are confined spaces with characteristically low flushing where frequent algae blooms can lead to hypoxic or anoxic conditions. Fish often enter dead-end canals because of the deeper and cooler waters found there and become trapped when the conditions become intolerable. Within the Coastal Bays watershed, fish kills were reported in canals more often than in any other type of water body (Figure 8.3.1). Fourteen of the eighteen reports involving canals were attributed to low dissolved oxygen. The vast majority (97.9%) of mortalities also occurred within canals (Figure 8.3.2). In addition to fish kills, citizen complaints about nuisance algae in canals were common in the summer time.

Several factors combine to explain reports in canal habitats. Excess nutrient runoff and poor circulation/flushing contribute to algal blooms, diurnal dissolved oxygen sags, and elevated Biological Oxygen Demand (BOD). Additionally, dead end canals may act as traps for wind blown floating macroalgae. Canals may also act as traps for schooling fish with poor maneuverability in shallow inshore environments. Concentrated fish that have been corralled into canals by predatory fish, or have simply wandered there, can become entrapped by low tides. This often results in the critical depletion of available oxygen due to a combination of fish respiration and natural diurnal oxygen depression.

Another explanation for the number of reports from canals depends on the fact that reports require an observer. With a large population living along canals, the probability of an observer seeing dead fish in a canal is high. There are fewer potential observers for dead fish in more remote areas.

The second most common habitat for fish kill reports is tidal creeks and rivers. Of the 16 reports from creeks and rivers, all but one occurred in smaller creeks near tidal headwaters. The most common cause of these events was low dissolved oxygen (five of eight events where cause was determined).

Table 8.3.1- Fish Kill Reports by Month: 1984-2003.

Month	# Reported Kills Statewide	# Reported Kills Coastal Bays
January	57	4
February	53	3
March	94	0
April	176	2
May	443	3
June	445	7
July	405	9
August	332	18
September	213	2
October	58	1
November	24	2
December	15	0

Trends of fish kills

Temporal Patterns

The majority of fish kills occurred in the summer months in the Coastal Bays Region as they did throughout the state (Table 8.3.1). Algal blooms, lower oxygen solubility, increased temperatures, increased BOD from organic decomposition, and larger fish stocks all occur in summer months. A small increase in the number of kills occurs in the Coastal Bays Region in the months of January and February. This is largely due to the fact that schools of five to eight inch striped mullet (*Mugil cephalus*) were found dead and dying of cold stress in each of the last four winters throughout the area. While most fisheries accounts of the Middle Atlantic Region suggest that the species leaves the area in fall and moves south, apparently some attempted to over winter in the area.

The number of fish kills reported per year varied following trends in ease of reporting, public awareness about fish health and environmental concerns, disease outbreaks, and cyclical trends in weather (i.e., drought, cold winters, cool summers, wet years). The number of kills reported per year does not appear to be changing statewide (Table 8.3.2). However, the number of fish kills reported per year in the Coastal Bays Region increased with time. The average number of kills reported in the late 1980's through the 1990's was 1.5 per year. That number increased to seven per year over the last four years.

Either increased environmental stress or increased public awareness resulting from renewed interest in environmental initiatives in the Coastal Bays area may explain the increase in fish kill reports.

Table 8.3.2- Fish Kill Reports per Year

Year	# Reports Statewide	# Reports Coastal Bays
1984	25	0
1985	90	3
1986	136	0
1987	148	1
1988	187	0
1989	122	1
1990	105	2
1991	120	0
1992	99	2
1993	103	3
1994	84	4
1995	105	2
1996	87	1
1997	87	3
1998	100	0
1999	132	1
2000	178	4
2001	129	5
2002	149	14
2003	127	5
TOTAL	**2327**	**51**

Table 8.3.3- Fish Kills by Cause: 1984-2003

Cause of Fish Kills	Statewide Cases (% where cause is known)	Coastal Bays Cases (% where cause is known)
Low Dissolved Oxygen	**751 (45.8 %)**	**24 (66.7%)**
General	270	4
Algal bloom	185	6
Entrapment	113	12
Intrusion/Inversion	67	1
Stranding	49	1
BOD	15	0
Winter Kill	52	0
Unknown	**595 (26.6%)**	**13 (26.5%)**
Discards	**301 (18.4 %)**	**4 (11.1 %)**
Thermal Stress	**37 (2.3 %)**	**5 (13.9 %)**
Disease	**196 (12.0 %)**	**0**
Seasonal/Spawning Stress	**103 (6.3 %)**	**0**
Pond Management	**42 (2.6 %)**	**1 (2.8 %)**
Misc. Natural	**15 (0.9 %)**	**0**
Storm Winds	**1 (0.1 %)**	**1 (2.8 %)**
Pollution	**188 (11.5 %)**	**1 (2.8%)**
Toxic Algae	**4 (0.2 %)**	**0**
TOTAL KILLS	**2233**	**49**

Cause

Approximately 12% of all fish kills statewide were pollution related. Pollution induced fish kills were direct results of discharges of some kind (i.e., sewage spills, manure spills, pesticide misuse, chlorine discharges, or chemical spills). Other kills like fishing discards arose directly from anthropogenic factors. Natural kills may be entirely natural occurrences, such as spawning stress, or arise in part from anthropogenic factors, such as nutrient runoff.

Statewide, approximately half of all tidal fish kills where the cause was known were attributable to low dissolved oxygen (Table 8.3.3). These events may have been due to strandings of schooling fish in tidal headwaters, entrapment in commercial fishing nets or other man made structures, low dissolved oxygen (DO) that could be attributed to nightly DO sags resulting from algal blooms, inversions, or intrusions of deep anoxic water onto shorelines. Low dissolved oxygen was implicated in two thirds of all fish kills where the cause was known in the Coastal Bays Region. While entrapment in man-made structures accounted for 15 percent of all low DO kills statewide, this accounted for half of all low DO kills in the Coastal Bays.

Mortalities

Of the estimated 37,500,000 fish mortalities statewide since 1984, 93 percent died in low DO events. Of the 3,302,300 fish mortalities in the Coastal Bays Region, approximately 98 percent died in low DO events (Table 8.3.4). The species most affected were schooling species, such as Atlantic silversides (*Menidia menidia*), Atlantic menhaden (*Brevoortia tyrannus*), and striped mullet (Table 8.3.5).

Table 8.3.4: Fish mortalities by cause: 1984-2003.

Cause of Fish Kills	**Coastal Bays Mortalities**	**Statewide Mortalities**
Low Dissolved Oxygen	**3,231,858 (97.9%)**	**34,699,050 (92.6 %)**
General	15,277	3,895,600
Algal bloom	3,862	13,062,500
Entrapment	3,200,719	3,563,700
Intrusion/Inversion	10,000	317,100
Stranding	2,000	13,492,100
BOD	0	317,550
Winter Kill	0	50,500
Unknown	**34,350 (1.0 %)**	**698,225 (1.9 %)**
Discards	**30,712 (0.9 %)**	**132,200 (0.4 %)**
Thermal Stress	**4,900 (0.1 %)**	**38,700 (0.1 %)**
Disease	**0**	**850,900 (2.3 %)**
Seasonal/Spawning Stress	**0**	**20,200 (0.0 %)**
Pond Management	**300**	**34,100 (0.1 %)**
Misc. Natural	**0**	**5,800 (0.0 %)**
Storm Winds	**25**	**25 (0.0 %)**
Pollution	**150**	**955,700 (2.6 %)**
Toxic Algae	**0**	**17,400 (0.0 %)**
TOTAL KILLS	**3,302,295**	**37,452,300**

Table 8.3.5: Mortalities of fish by species in the Coastal Bays region: 1984-2003.

Fish species	**Number killed in Coastal Bays**
atlantic silversides, *Menidia menidia*	3,000,000
atlantic menhaden, *Brevoortia tyrannus*	290,675
striped mullet, *Mugil cephalus*	4,950
bluegill sunfish, *Lepomis macrochirus*	1,815
golden shiner, *Notemigonus crysoleucas*	1,375
minnow species	636
black sea bass, *Centropristis straita*	500
18 remaining species	2,344

Summary

The only pollution case in the Coastal Bays Region took place on August 7, 1993 in Bishopville Pond. A sudden collapse of a storage tank at a plant in Selbyville, Delaware caused approximately 250,000 gallons of chicken processing waste to spill into the creek feeding Bishopville Pond. Fish mortalities occurred during the night, but were cleaned up by contractors before MDE biologists could accurately assess the damage. At least 150 fish died. No acute effects were visible below the pond in Bishopville Prong.

Fish kill events in order of severity were:

1. **August 30, 2001** in a canal off Isle of Wight Bay in West Ocean City. A school of 3,000,000 Atlantic silversides entered the canal, which had a sand bar partially blocking its mouth, and apparently became entrapped during low tide overnight. The fish became concentrated by low water, exhausted all available oxygen, and died. DO at the time of investigation varied between 0.05-2.1 mg/l.
2. **September 22, 1997** in a canal off Assawoman Bay in Ocean City. Approximately 200,000 Atlantic menhaden apparently became entrapped in the canal and died of low oxygen. DO at the time of investigation was 0.77 mg/l.
3. **August 17, 2002** in Massey Branch, a tidal tributary of Marshall Creek. Approximately 30,000 Atlantic menhaden died. Investigation revealed that the creek was extremely shallow and the fish were likely stranded. Most of the dead fish were found in less than eight inches of water. Algal samples revealed a bloom of the potentially toxic alga, *Chattonella sp.* in the area. Other species of fish were unaffected.
4. **July 8,1993** in the Atlantic Ocean off Assateague Island. Approximately 30,000 adult Atlantic menhaden were discarded by commercial fishing operations.
5. **June 7, 2002** in a canal off Isle of Wight Bay in West Ocean City. Approximately 15,000 Atlantic menhaden died due to low DO.
6. **September 12, 1985** in a canal off the Saint Martin's River in Ocean Pines. Approximately 10,000 Atlantic menhaden died due to a storm induced anoxic inversion.
7. **January 17, 2001** in a canal off Isle of Wight Bay in Ocean Pines. Approximately 3,500 striped mullet died of cold stress under ice.

Acknowledgements

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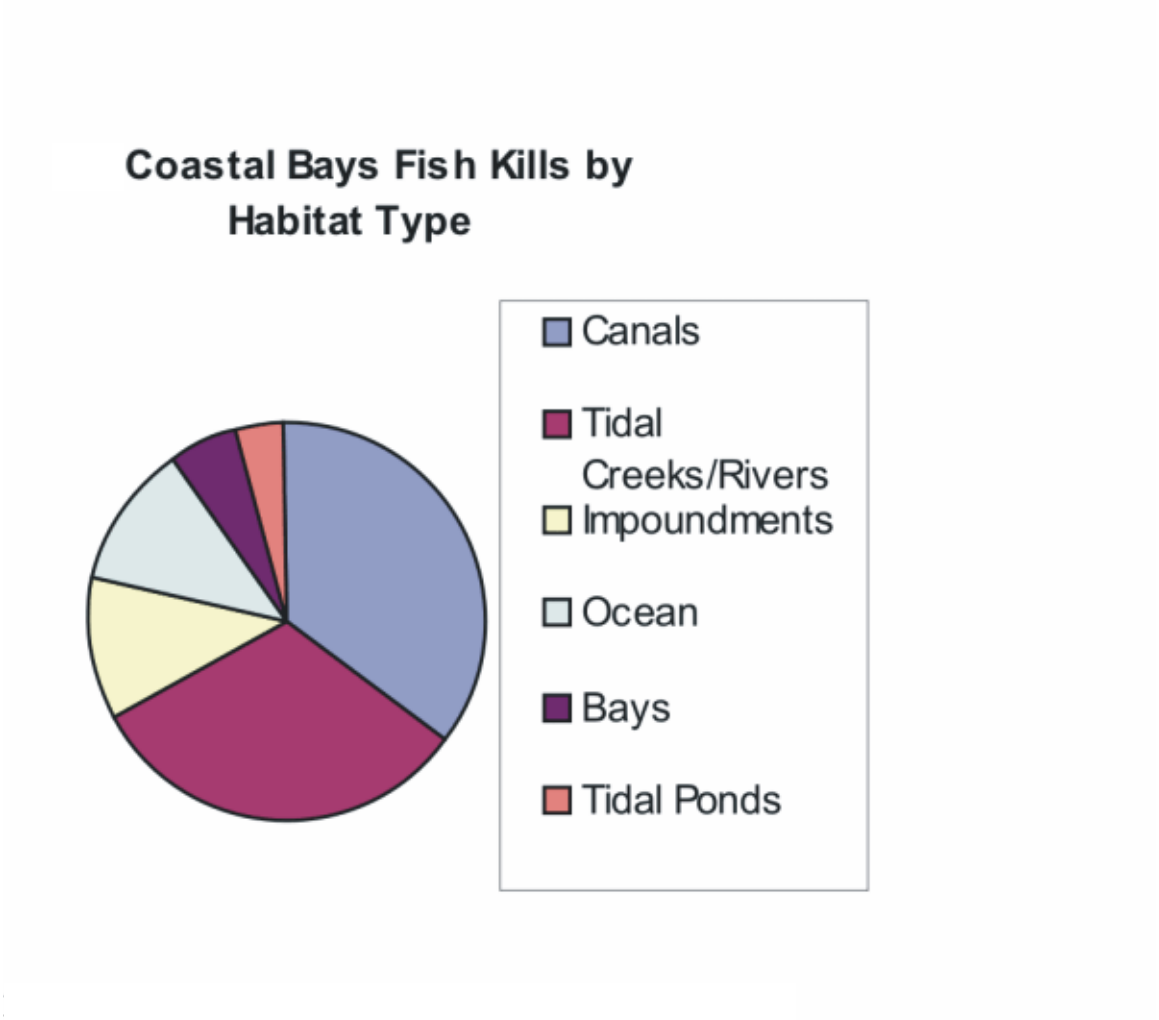

Figure 8.3.1. Number of fish kills per habitat type, 1984-2003.

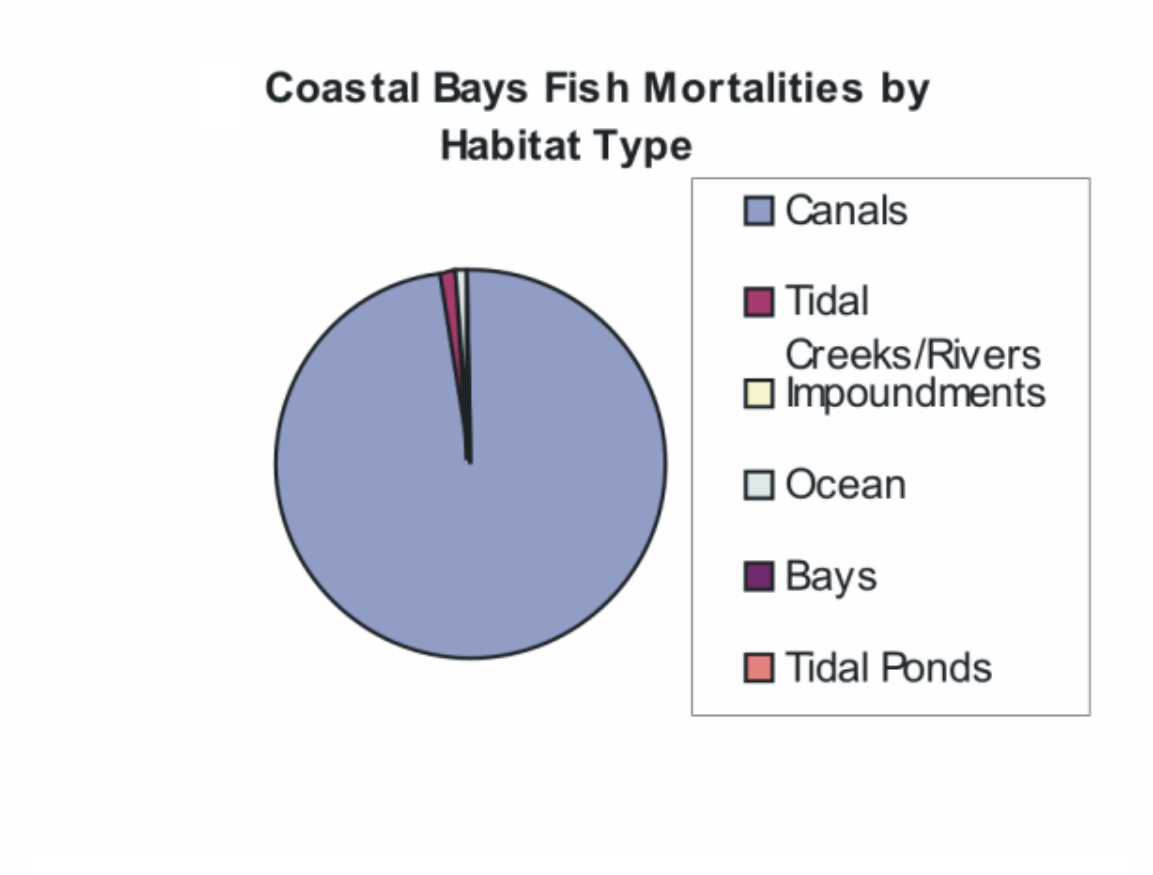

Figure 8.3.2. Numbers of fish killed during fish kill events per habitat type, 1984-2003.